A STUDY ON FACTORS INFLUENCING GREEN INFORMATION TECHNOLOGY ADOPTION AMONG MANUFACTURING FIRMS IN PENANG, MALAYSIA

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ABSTRAK

Sejak kebelakangan ini, kemampanan alam sekitar telah menjadi topik hangat yang kerap dibincangkan oleh ahli akademik dan pengamal. Keningkatan masalah alam sekitar seperti pencemaran, pemanasan global, kekurangan makanan, kehabisan sumber asli dan sisa pepejal telah menarik perhatian daripada sektor kerajaan, masyarakat serta organisasi perniagaan. Oleh sebab itu, kehijauan adalah cara-cara terkini yang terus ditumpu perhatian oleh masyarakat sejagat. Kehijauan Teknologi Maklumat *(Green Information Technology*, *Green IT)* adalah sebahagian daripada usaha organisasi perniagaan yang menuju ke arah menjadi lebih mesra alam. Oleh itu, kajian ini bertujuan untuk menyiasat faktor-faktor yang mempengaruhi organisasi ke arah menghijaukan IT. Untuk mencapai objektif kajian, analisis kuantitatif digunakan untuk mengedarkan soal selidik kepada firma-firma pembuatan di negeri Pulau Pinang. Data yang dikumpul kemudiannya diuji dengan perisian SmartPLS versi 2.0.M3. Hasil menunjukkan bahawa terdapat hubungan yang signifikan dan positif wujud antara faktor TOE (teknologi, organisasi dan alam sekitar) dan kehijauan IT diterima pakai. Selain daripada itu, tiada kesan signifikan yang ditemui pada saiz organisasi yang mempengaruhi hubungan antara faktor TOE dan kehijauan IT diterima pakai. Hasil daripada kajian ini boleh digunakan sebagai garis panduan bagi pengurus atau pasukan pengurusan atasan untuk mengenal pasti aktiviti-aktiviti yang akan mendatangkan manfaat berikutan pelaburan dalam IT Kehijauan. Selain itu, kajian ini juga berguna untuk penyelidik mengkaji dengan lebih lanjut terhadap pemandu-pemandu lain, nilai dan latar belakang kehijauan IT. Sebagai kesimpulan, kajian ini diakhiri dengan beberapa had-had dan cadangan untuk kajian pada masa hadapan.

ABSTRACT

In recent decades, environmental sustainability had become a hot topic being discussed by academicians and practitioners. The increase of environmental problems such as pollution, global warming, scarcity of foods, depletion of natural resources and solid waste had drawn attention from governments sector, communities as well as business organizations. Hence, going green is the latest approach that emphasized. Green Information Technology (IT) is part of the effort by business organizations to be green. This study aims to investigate factors influencing green IT adoption by manufacturing firms in Penang, Malaysia. Based on the Technology-Organisational-Environment theoretical model and related literature, a research model was developed to test the hypotheses proposed. In attaining the study objectives, a quantitative approach was used by distributing survey questionnaire to randomly sampled manufacturing firms in Penang state. The collected data is then tested with SmartPLS version 2.0.M3. The outcomes indicated that there is a significant and positive relationship exists between technological, organizational and environmental factors and green IT adoption. However, there is no significant moderating effect found on the organizations size to the relationship between the three factors and green IT adoption. The findings from this study serve as guideline for top management among manufacturing firms in Penang to uncover the various dimensions involved in IT adoption and understand factors that motivate organizations to invest in green IT. This study is also useful for researchers to further investigate on other drivers, values and antecedents of green IT. Lastly, this study concluded with some limitations and recommendations for future research.

CHAPTER 1

INTRODUCTION

1.0 Introduction

Chapter 1 presents the research outline of the study. It begins by introducing the background of the study and highlighting the problem statement of the study. It is then followed by the research objectives and research questions. Lastly, the chapter ends with the significance of the study.

1.1 Background of the study

In recent decades, sustainable development has emerged to become a hot issue for governments, societies, as well as businesses that ranging from underdeveloped, developing to developed countries. According Schmidt et al. (2010) study, the primary wisdom of sustainability can describe as the survival assurance. This means that the three extents, economic, environment and social system should conserve for future generations. Thus, only the necessary resources should be exploited, and to a certain degree where the resources can be restored within a regeneration cycle. Some other definitions are like sustainability is defined as the "An ongoing development that meets the current needs, without compromising the ability of future generations to meet their own needs" by Brundtland Commission. (WCED, 1987). In conclusion, all the definitions about sustainability are to have the protection of economic, environment and social system for the benefit of future generations. These dimensions

had built up as the three main pillars of sustainability. It is also known as the "triple-bottom-line" concept (Elkington, 1997).

During 1990s, Malaysia economic growth dramatically and increased its living standards. During that time, New Development Policy (NDP) had been introduced to increase economic wealth for entire country. Since then, industrialization and urbanization trends are obvious in Malaysia. Furthermore, the availability of professional workers, competitive labour cost and ideal business environment, Malaysia managed to encourage many foreign investments like multinational companies to set up plant in Malaysia. The country moved from an agriculture-based economy country to industrialized economy which focuses on manufacturing industry.

As the country continues to grow rapidly, the need of Information Technology (IT) is growing as well. One of the most notable projects is the launch of Multimedia Super Corridor (MSC) where its mission is to accelerate the objectives of Vision 2020 where transforming Malaysia into a modern country by year 2020. In order to facilitate the development and promotion of MSC Malaysia, the premier Malaysian initiative, Multimedia Development Corporation (MDeC) is established. MDeC is a unique high-powered government-owned corporation who in charge of advising the Malaysian government on information and communication technologies (ICT) legislation and policies. Besides, MDec also help to develop MSC Malaysia which is a key growth driver of the economy. It set the breakthrough standards for ICT and multimedia operations.

Since then, Malaysia is prepared to be part of the Information Age in the new century. Malaysia aimed to transform into a knowledge-based economy country. Recognizing the importance of IT and multimedia systems, various initiatives were taken to encourage the use and development of IT. Thus, IT will be the key to success

where it capable to increase the productivity, efficiency, and competitiveness of the country.

According to news published by Malaysia National IT Council, Malaysian IT spending is expected to increase from USD4.2 billion in year 2009 to around USD4.5 billion in year 2010 (NITC Malaysia, 2012). Because of the rise in business spending on IT hardware, software and applications, BMI had forecasts a 7 percent growth in Malaysia IT spending in 2010. Furthermore, the demand from key sectors such as data storage centres and cooling systems has driven business firms to invest more in IT. As a result, the power consumption for computers, servers and its infrastructure had reached 123 billion kWh in year 2005 worldwide (Syzdykbayeva, 2009) with similar trend in Malaysia as well based on anecdotal evidence. Since then, the figure is increasing annually. The burst of demand in power usage had an impact to environmental problems. Malaysia, a developing country is facing the same problem; monthly demand on electricity supply had increase from 91MWatt in January 2008 to 138MWatt in June 2010 (Interim Report on the Performance of The Electricity Supply Services in Malaysia, 2010). Thus, to address the issue of saving cost in IT and reduce CO2 emissions, going green is the crucial way.

As with many business improvements, IT is one of the key enablers of low carbon economy. The global carbon emissions resulted from ICT activities have been estimated at 2% to 2.5% of worldwide totals, i.e. about the same as the airline industry and forecasted to be triple in year 2020 (Popescu, 2009). Hence, greening IT started to attract the attention of IT managers and policy makers among business organisations. The role of IT in causing and resolving sustainability issues is increasingly significant. In Molla (2009), there are two main and interconnected streams of view that can be identified in recent discussed on green IT. The first one is

by reduce the carbon emission and wastage in every stage of IT resources lifecycle, which is from sourcing, manufacturing, usage and disposal. Secondly, IT can be deployed in measuring, monitoring and reporting all the relevant IT activities. Actions like reduce greenhouse gas emissions, avoid unnecessary waste and control water usage should be existing within business processes core value (Molla, 2009).

The overall potential of IT in fighting climate change is a significant and attractive to businesses. It is estimated that ICT can reduce emissions by 7.8 GtCO2e by 2020, which is five times more than its own carbon footprint (Tenhunen, 2011). So, once IT is greener, the effects on every industry can be developed and implemented at a larger scale. Hence, studying the factors to green IT adoption in business and strategies will helps to understand how well companies are inclined towards green IT.

1.2 Problem Statement

Because of the rising technologies and explosive growth of Internet, business operations have emerged from domestically to internationally. With the aid of information technologies (IT), business firms are capable to expand either vertically or horizontally. Thus, the need of IT is increasing year by year (Beurer-Zuellig & Meckel 2008), where the information and communication technologies sector has grown from 5.8 percent of global GDP in year 2002 to 7.3 percent in year 2007 and is expected to reach 8.7 percent of global GDP by year 2020 (The Climate Group 2008). However, the usage of IT and disposal of IT activities had brought a negative impact to the environment (Elliot & Binney, 2008). The rapid change of technologies has resulted increase in electronic products obsolete pace as well. This kind of electronic waste (e-waste) is one of the major causes to environmental contamination (Herat & Bahadir, 2007). The increase in number of IT infrastructure such as personal

computers, servers and others had lead to the increase in power consumption. Thus, the extra demand in energy and resource had contributed to the extra generation of greenhouse gases (GHG). This is yet another impact to the environment in global warming and climate change (Katzer et al., 2007; The Climate Group, 2008).

In developing countries such as Malaysia, manufacturing industry plays an important role in transforming the country. According to Juhaini et al. (2011), manufacturing industry has expanded 6.3 per cent during 2008 despite the economic downturn and was the strongest industrial sector in Malaysia during that time. It is observed that manufacturing industry is expected to growth in recent years but on the other hand, it will bring a negative impact on the environment.

At present, the practice of green IT amongst manufacturing firms in Malaysia is not widely prevalent and can be categorized as in the early stage. Literature addresses green IT in Malaysia context is very limited. So, there is a growing need to determine the level of readiness among manufacturing firms in Malaysia and to investigate the drivers that influence these organizations to embrace green IT in order to meet global demands, reduce infrastructure costs, associate energy and save space. This study intends to use a relevant research methodology to analyze the data that will be gathered in addressing the research questions and provide suggestions for the key factors of concern which influence adoption of green IT among manufacturing firms in Penang, Malaysia.

1.3 Research Questions

This research has been carried out to test general hypotheses of factors influencing green IT adoption among manufacturing firms in Penang Malaysia. Hence, this study is designed to answer the following research questions:

i. To what extent have manufacturing firms in Penang, Malaysia implemented green IT?
ii. Does the technological factor influence the adoption of green IT among manufacturing firms in Penang, Malaysia?
iii. Does the organizational factor influence the adoption of green IT among manufacturing firms in Penang, Malaysia?
iv. Does the environmental factor influence the adoption of green IT among manufacturing firms in Penang, Malaysia?
v. Does the difference in organizational size influence the relationship between the technology, organization and environment factors to green IT adoption?

1.4 Research Objectives

This study is worthwhile, as Malaysia launched of Economic Transformation Program (ETP) in year 2010, there will be increase in number of foreign investors coming to Malaysia. The ETP is a comprehensive effort that will transform Malaysia into a high-income nation by year 2020. Thus, identification of the drivers to green IT adoption among manufacturing firms in Malaysia is fairly important in order to achieve win-win situation between economy and environmental sustainability.

Therefore, this study attempts to accomplish the following objectives:

i. To investigate the extent of green IT adoption among the manufacturing firms in Penang, Malaysia.

ii. To examine the relationship between the technological factor and the extent of green IT adoption among manufacturing firms in Penang, Malaysia.

iii. To examine the relationship between the organizational factor and the extent of green IT adoption among manufacturing firms in Penang, Malaysia.

iv. To examine the relationship between the environmental factor and the extent of green IT adoption among manufacturing firms in Penang, Malaysia.

v. To examine if organizational size moderates the relationship between the technology, organizational and environment factors and the extent of green IT adoption among the manufacturing firms in Penang, Malaysia.

1.5 Scope of Research

There have been studies done in Australia and Western countries on green IT. The extent of green IT, its driving factors and inhibitors are discussed by researchers. However, there are limited studies done in Asia especially in Malaysia context. This study attempts to investigate the factors that drive green IT adoption in manufacturing firms in Malaysia. However due to the nature of the study, and the challenge to directly examine the respondents, the manufacturing sector located in the state of Penang only has been administered manually. It is worth to concentrate in Penang state because of Penang is the highest manufacturing investments state in the country with RM9.1 billion (InvestPenang, Press Release, 2012a) and being the first state to practice "No Plastic Bag Day" in shopping centres and hypermarkets since 1st Jan 2011 (InvestPenang, Press Release, 2012b).

1.6 Significance of the Study

The past decade has seen many businesses realize the long term effects of pollution and taking responsibility for their actions in ways that improve their environmental footprint. Nevertheless, the role of information and communications technology in causing and resolving eco-sustainability issues (usually referred to as green IT) is an under-researched area. The relationship between green and IT need to be investigated. This study is expected to contribute to the body of knowledge about green IT adoption theory and practice. It is expected to bring benefit to the researchers and practitioners by providing a broader view and significant area of influence from this study.

Green IT is still at early stage in Malaysia, especially in the manufacturing sector. There is very limited academic research attention in this research area. Thus, in terms of theoretical contribution, this study aimed to investigate the factors

influencing green IT adoption among manufacturing firms in Penang Malaysia based on the Technology-Organizational-Environment (TOE) framework. This study provides significant empirical evidence to identify and critically evaluates the factors that drive businesses to adopt green IT. From the study by Kuo and Dick (2009) as well as Molla (2009), TOE framework which is technology, organization and environmental had been identified as the factors influencing green IT adoption. Besides, this study conceptualized the adoption of green IT based on a holistic green IT matrix developed. The combination of breadth (sourcing, operation, services and end of IT life management) and depth (policies, practices and technologies) are demonstrated into a matrix. In addition, a moderator which is the size of organizations in term of number of employees was also introduced in the study proposed by this study.

From the practical point of view, this study is important in understanding the key factors that influencing green IT adoption. Nowadays, IT plays an important role in environmental sustainability. Many businesses in developed country are aware of green IT issue and started to implement in their strategies or policies. Thus, for developing country like Malaysia, it is important for manufacturing firms to embrace green IT in order to meet global demand towards green and sustainable development. The findings from this research is therefore serve as a guideline for top management team to strategize and implement appropriate actions towards green IT adoption for better performance. Besides, researchers can use this study to understand the important drivers and values which influence the green IT adoption. On the other hand, the findings will offer a standard for practitioners to assess and evaluate their green IT adoption. It is also able to compare with the initiatives and progress by their peers as well as their competitors.

This research is the empirical study in order to understand green IT adoption in Malaysia. The findings from this study will theoretically contribute to the existing knowledge on green IT while practically provided some useful recommendations for practitioners like Chief Information Officers (CIOs), IT managers, environmental and sustainability managers. Lastly, this study also offers new opportunities for further research in this area.

1.7 Organization of the Remaining Chapters

This report is organized as follows: Chapter 1, the current chapter is an introductory chapter that provides the background of study, research questions, research objectives and discussion on its context. Follow by Chapter 2 which reviews on the related literatures of theories, framework and variables for this study. Then, Chapter 3 is mainly concentrates on the chosen research framework, design of study and methodological procedures. Next, Chapter 4 presenting the findings where data analysis will be done on the results obtained from survey and the research hypotheses are tested and elaborated. Lastly, Chapter 5 which is the concluding chapter, presenting on the discussions, implications and limitations of the study.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

There are many published literature and past studies on green information technology (IT) and its driving factors. This chapter first reviews the published literatures on the environmental sustainability, corporate social responsibility, definition of information systems (IS) and definition of IT. The chapter follows by the review on background of green IT and its factors that drive organizations to adopt green IT. These literatures are important as they provide strong support to the background of this study and used as fundamental on building theoretical framework and methodology. This chapter end with the gaps identified from previous studies.

2.1 Environmental Sustainability

Environmental sustainability is becoming an essential and universal public issue today. Climate change, the depletion of natural resources, world population increase, scarcity of food and others had draw a high attention to the people. During the past few years, political discussions are intense and widespread coverage in the media in resulted communities around the world has awakened to the environmental sustainability issue. Nowadays, climate change and the environmental problem had become people most concern and caring issue. Somehow, environmental problem is highly discussed than any other socio-political matter. This can be further proven in Bonini et al. (2008) study. Consumers' feedback that a corporation's strategic move towards handling

climate change and environmental problems will affects them in their trust to the company resulted whether they would purchase its products. Bonini et al. (2008) also stated that consumers want companies to promote the public good by providing healthier and safer products.

This has driven corporate started to identify that this attitude is a business reality and start to pay attention on environmental sustainability issue. As an example, corporate carbon footprint has become an important topic among business entities. Enkvist et al. (2008) suggested that the trend towards a less carbon emission initiative is already on the move and that business must get prepared for the transformation. These are especially in energy, heavy industry, manufacturers and transportation industry. As proposed by Enkvist et al. (2007), sustainability has an "elementary impact on key issues of business strategy, such as production economics, cost competitiveness, investment decisions, and the value of different types of assets". Therefore, firms or organizations from the heavy concern industries would think wisely the effects of different policies and regulations, the way to strive and form it, and as well as position themselves accordingly in the society. In other words, all businesses should take this into consideration where the activities handling on environmental issues can become their corporate strategy. Efforts like offering products and services that fulfil customers needs, wants and concern is a way for business firms to build confidence and create loyalty among customers.

There are many definitions on environmental sustainability. According to Russo (2003), the term sustainability has "acquired so many overlapping definitions and the definitions seem to be increasing in number of words." An appropriate definition is proposed by the World Commission on Environment and Development (1987) who suggest that sustainability is "development that fulfils the present needs

without threaten the future generations' ability in acquiring their needs". This definition had been widely adapted in many researchers study.

In Dyllick and Hockerts (2002), researchers had identified three goals of sustainability. They are identified as eco-efficiency, eco-equity, and eco-effectiveness. Firstly, eco-efficiency is defined as meeting the human needs by offering the competitively-priced goods and services that capable to bring quality of life. At the mean time, while businesses running their daily activities; they should also putting effort on reducing negative environmental impacts throughout the life-cycle. Eco-equity refers to the relationship between the management of natural resources and social sustainability. Thus, eco-equity is explained as the equity between current and future generations and, in particular, the equal rights of all peoples to environmental resources". Lastly, eco-effectiveness is refers to the operations or activities which should be done right things on the right goods and services, without wasting the resources either in term of time, manpower or resources with unnecessary error and mistake.

With regards to IT, Molla, Cooper & Pittayachawan (2009) implied that sustainability issues should be extended to IT related area such as IT infrastructure, IT systems and IT report and management. IT infrastructure in terms of the basic technology components can be including resource planning and management capabilities. IT infrastructure also can be conceptualized as IT and communications technologies, shared services and business applications that utilize the shared infrastructure. Thus, IT applications can be directed towards solving both IT and non-IT (by using IT) that related to sustainability problems.

Although business emphasize on sustainability seem to be an extra investment, like adopting new technologies and practices that are more efficient and effective

which involve a larger amount of money. But Watson et al. (2010) goes on to propose that “seeking sustainability does not mean abandoning economic thinking”. Just like Molla (2009) argued that business seeking for environmental sustainability is just one of the three pillars of sustainability. The other two are economy and community. Modernization and industrialization lead to increase in number of IT and its related equipments. Larger data centres consume much power. Thus, with a focus on IT, Watson et al. (2010) states that “IT investments are growing, and sustainability requires a reduction in computer related energy consumption”. This can be seen as a direct link to green IT.

2.2 Corporate Social Responsibility

These years, the word “sustainability” or corporate social responsibility (CSR) had been widely discussed within business and corporate. Topic like greening the business or to become more eco-efficiency are among the hot issues stress by businesses. Even though there had been several studies conducted on sustainable management, there is never has a straight forward to define what is “Corporate Social Responsibility”. The key point to best describe sustainability is assured of survival. This means that economic, environment and social system should be conserved for the future generations. Only the needed of resources without unnecessary waste should be used. And is to be used till a degree where it is able to restore them within a regeneration cycle (Schmidt et al. 2010). The growing interest in CSR among companies, governments and the general public has only served to extend the array of CSR definitions. Some of the common definitions are as below:

1.) World Bank define CSR as the promise of business to contribute to sustainable economic development, working with employees, their families, the local

community and society at large to improve quality of life, in ways that are both good for business and good for development" (World Bank, 2003).

2.) European Commission has a new definition of CSR as "the responsibility of enterprises for their impacts on society" (European Commission, 2011).

3.) Lord Holme and Philip Watts from the World Business Council define CSR as the ongoing commitment by business to perform ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large.

As we can see, mostly definitions on sustainability are in common. It is all about the protection of the economical, environmental and social system for the good of future generations. Thus, the different definitions of CSR and the vast variety of corporate social responsibility activities practiced by companies can be concluded as the managing of value added activities which focusing on the "triple bottom line" which are economic, social and environmental.

Molla, Cooper and Pittayachawan (2009) state that in coming years, CSR and compliance with new stringent energy legislation and regulations will force governments and business alike to reduce their impact on the environment through sustainable policy, energy efficiency and following environmentally safe practices. Furthermore, IT plays an integral role in almost all areas of businesses ranging from early stage such as sourcing till the end of life, disposing stage. Thus, with special emphasis on IT, Molla, Cooper and Pittayachawan (2009) see a development where "CSR and environmental sustainability should be extended to IT too."

Today, sustainability in IT is yet to be thoroughly evaluated. But, due to the global development and rises of challenges, it is needed to make IT as part of corporate strategy. For example, sustainability in IT can be included in the corporate

missions. One of methods that mostly practice by business firms is to go green. The global issues such as the depletion of natural resources and the stakeholders' environmental awareness has become the motivations that drive business firms to go green (Tenhunen, 2011).

2.3 Green IT Initiators

Since the early 1990s, many governmental agencies started to launch and execute principles and rules that promote green computing or green information technology.

2.3.1 Energy Star

ENERGY STAR with the objective to help consumers save money and at the mean time protects the environment through encouragement on products that are energy efficient. It is a joint program that developed by the U.S Environmental Protection Agency and the U.S Department of Energy (Energy Star, 2012).

In 1992, ENERGY STAR was launched. It is a voluntary labeling program intended to promote and recognize energy-efficient products with the aim to reduce greenhouse gas emissions. Personal computer and its monitor screen are the very first labeled electronic products. Since then, EPA extended the label to other products like climate control equipment and organization electronic equipment, lighting, household electronics and others. All these labeling is covering from residential home till commercial and industrial buildings.

This resulted in the widespread adoption of sleep mode among consumer electronics. The Energy Star program was further enhanced in 2006. Computer and its related equipment are required to a stricter energy efficiency level. Tiered ranking system is implemented in order to approved and categorizing products (Popescu et al.,

2009). Today, Energy Star program had been proven a strategy that can protect environment while stimulating the economy. Benefits have grown steadily since the program's inception and will continue to grow as consumers and businesses further leverage Energy Star.

2.3.2 The Swedish Organization TCO (Tjänstemännens Centralorganisation) Development and TCO Certification

TCO Development works is to make sure that IT users have good products and equipment to use, while protection of as minimum as possible impact to the environmental (TCO Development, 2012b). At first, TCO Certification program is to encourage low magnetic and electrical emissions from computer monitor. Later on, the program was further extended its standard like lower power consumption, improved picture quality and visual ergonomics, and the reduction of dangerous materials in construction.

Consumers alert on environmental issues and will looking for products that are environmental friendly. As a result, an increasing number of manufacturers' products were build to comply with TCO standard. By means of the TCO labeling system, consumers have the influencing power where the development of products may follow to the direction as mentions above.

2.3.3 Climate Savers Computing Initiative (CSCI)

CSCI was started in year 2007 with the aim to reduce the electric power consumption of PCs in active and inactive states. The CSCI provides a catalogue of green products from its member organizations, and information about ways to reduce PC power consumption.

2.3.4 The Green Grid

The Green Grid is a non-profit, open industry consortium of end-users, policy-makers, technology providers, facility architects, and utility companies collaborating to improve the resource efficiency of data centers and business computing ecosystems. It was founded in year 2007 by several key companies in computing industry which is AMD, APC, Dell, HP, IBM, Intel, Microsoft, Rackable Systems, SprayCool, Sun Microsystems and VMware. Nowadays, The Green Grid has more than 175 member companies around the world, which seeks to unite global industry efforts, create a common set of metrics, and develop technical resources and educational tools to further its goals. (The Green Grid, 2012)

2.3.5 Green Information Technology in Malaysia

Malaysia started green and sustainable development towards environmental protection by implement green policies. Some of them are like using or purchasing renewable energy, promoting energy efficiency policy and advocate the use of green technology. One of the most important policies is the launched of Green Technology Policy (NGTP2009). It is a milestone for Malaysia on the green development effort.

Under the NGTP2009 policy, Malaysia took initiatives by implementing many programs such as green financing scheme, Green Township, green procurement and eco-labelling, green vehicles, green awareness, green conferences which govern by different department. In year 2009, Ministry of Energy, Green Technology and Water was established to manage the country energy, green technology and water usage. It is then develop green technology policies and roadmaps. Besides, Malaysia government also set up Green Technology Council (GTC) in the same year to speed up the

progress of green technology in Malaysia. Malaysia Green Building Confederation (MGBC) is the leader in promoting green building and green practice within the growing construction market sector (Chua & Oh, 2011).

The green initiatives in Malaysia had proven to give many benefits and incentives such as saving in energy related costs, save the depletion non-renewable fuels, preserving the environment and improve foreign reserves. Thus, a variety of green initiatives is currently under progress and supported by Malaysia government. With the help and cooperation from public and private sectors, the green future is extremely clear in Malaysia (Chua & Oh, 2011).

2.4 Definition of Terms

2.4.1 Information Systems

Information systems are the combination of hardware, software, communications networks, data resources and trained personal that support data-intensive applications such as stores, retrieve, transforms and disseminates information in an organization. In short, information systems help businesses improve efficiency and effectiveness, as well as decision making.

Since last decade, there are numbers of studies by researchers on environmental sustainability, but less on the field of IS. Given the revolutionary effects, ISs are of utter importance in the pursuit of environmental sustainability Chen et al. (2008).

Melville (2010) highlights the relationship between sustainability and IS where IS enables firms to monitor, storing and utilize data and metadata that facilitates energy efficiencies. According to Melville (2010), the role of IS may have dual effects. The first is to increase energy use by increasing its efficiency and

productivity in organization. The second is to decrease energy use by dematerialization or reducing energy needs through enhanced computerized design and control.

Innovation in IS having the potential for a complete transformation of an organization and an industry. Thus, IS can be seen as a weapon or corporate strategy of organizations in their quest for environmental sustainability by enabling new practices and processes like automation technology which support of belief formation, action formation, and outcome. (Melville, 2010)

2.4.2 Green Information System

In Watson et al. (2010) study, they argue that exclusive focus on information technologies is too narrow and should be extended to information systems. They propose that definition of green IS should encompassing on IT or inclusive of green IT. Thus, the term green IS & green IT had been combined by researchers where IS and IT are known to be the products like software that help to handle organization's practices like dumping of end of usable life IT products in an environmentally friendly method. It is aims to attain sustainable development goal by pollution prevention and product stewardship.

2.4.3 Information Technology

Information Technology is part of information systems. IT refers to both the hardware and software that are used to store, retrieve and manipulate information. IT also may refer as the foundation of information systems.

Nowadays, IT has been contributing to environmental problems. IT practitioners and academicians had been linking IT with sustainability. According to

Molla, Cooper and Pittayachawan (2009), organization's IT applications can be directed towards solving IT related sustainability problems. Computers and IT related infrastructure consumer significant amounts of electricity and contributing to greenhouse gas emissions. Moreover, IT hardware poses severe environmental problems from its production stage till its disposal stage. Thus, to reduce IT environmental problems and create a sustainable environment, greening IT will touch into many other areas in an organization and can have significant impact on the overall sustainability of a business.

2.4.4 Green Information Technology

Information technology or information system is growing rapidly since the last decade. IT plays an important role in business world today. The increasing need of IT has bringing some impact to the world. The revolution of IT has evolved the way human communicate where human are more easily stayed in touch with one another with the use of IT. On the other hand, IT also brings a negative impact on the environment and creates eco-sustainability issues. As a result, firms or enterprises are increasingly challenged by the changing demands of their stakeholders in the scope eco-sustainability awareness and social consciousness. Thus, people are become very largely concentrated on concerns about green IT.

Although the term green IT is becoming more common in discussion, there is still little common understanding of what this term actually means. Green IT refers to environmentally sound IT. It is the study and practice of designing, manufacturing, using and disposing of computers, servers and associated subsystems such as monitors, printers, storage devices, and networking and communications systems which efficiently and effectively with minimal or no impact on the environment (Murugesan,

2008). While Tenhunen (2011) referring green IT to the energy efficiency of data centre and other equipment. The data centre energy challenge affects both the physical data centre and the IT infrastructure. So, in order to reduce the electricity usage for the cooling systems and the electrical and building systems of a data centre, optimize the data centre infrastructure energy efficiency is the methods towards greening IT. Molla (2009) proposed that green IT means many things to different people. It involving IT infrastructure and green supply chains, and emerging practitioner oriented green IT publications. With the combination of all the above, Molla has come out a definition on green IT,

> "Green IT is an organization's ability to systematically apply environmental sustainability criteria (such as pollution prevention, product stewardship, use of clean technologies) to the design, production, sourcing, use and disposal of the IT technical infrastructure as well as within the human and managerial components of the IT infrastructure".

Thus, green IT is the value chain of IT departments that can be divided into four different but interrelated perspectives which are sourcing, operations, services and end of IT life management.

Besides, green IT can be refer to the using of IT resources in an energy-efficient and cost-effective manner. It is defined as computing technologies that are energy-efficient and have minimal adverse impact on the environment (Nishant et al., 2011). Some researchers are using the term green computing instead of green IT. Green computing is the study and practice of efficient and econ-friendly computing resources with conservation of power energy (Appasami & Joseph, 2011). Thus, in Syzdykbayeva (2009) study, the main purpose of green computing is using computing resources for reducing IT operations cost, hazardous emissions and taking part in

reducing greenhouse gases that decreasing global warming. Greenhouse gas (GHG) emissions have being a real concern and important issues for every business firms. In some studies, researchers see reduce, control GHG emissions as part of green IT.

Green IT can be range into many focal points and different actions. According to Murugesan (2008), it including power management, energy efficient practices, data centre design for environmental sustainability, server virtualization, end of IT life like disposing and recycling, uses of renewable energy resources and eco-labelling of IT products. In short, green IT can be known as the coverage of environmental sustainability dimensions, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling. Thus, green IT aims to accomplish economic feasibility and enhanced system performance and use, while remaining the social and ethical responsibilities.

2.5 Technology-Organization-Environment (TOE) Framework

According to Molla (2008), many studies that conducted on the organizational adoption of green IT are practicing the use of empirical research models. The models are based on a broad range of views such as technological perspective, managerial action perspective, organizational perspective and the institutional perspective. Gonzalez (2005) study on factors influencing clean technology adoption was also follows one of the perspectives.

Molla (2008) discussed that different models had been proposed and developed by researchers to study on green IT adoption. Technology Acceptance Model (TAM) is the model or framework that being developed to concentrate on the technological related determinants of the adoption and diffusion of innovations. Besides, Diffusion of Innovation (DOI) is another model that emphasize on the

characteristics or perceived characteristics of an innovation such as complexity, compatibility and relative advantage. While the managerial innovation model was used to study the adoption of new technologies based on managers' awareness of problems and also based on organizational culture that whether risk taking or risk averse.

Technology-organization-environment (TOE) theory was proposed and developed by Depietro et al. (1990). According to the theory, the organizational adoption and execution of technological innovation is influenced by three elements (Bose & Luo, 2011). First, the technological context is refers to two characteristics which is internally and externally. Externally is the characteristic of technologies which are currently available and possible for organization to adopt. While internally refers to the present use of technology like IT equipments and practices in the organization. Second, the organizational context consists of organizational structure, the presence of innovation-enabling processes such as informal communication and strategic behaviour of leaders, and the size and slack resources of the organization. Third, the environmental context is the combination of the market structure element and its characteristics, the availability of external support for adopting new technologies and government regulations (Bose & Luo, 2011). These three elements are posited to interact with each other and to influence technology adoption decisions (Depietro et al., 1990).

Greening IT, is like innovations in technologies. Thus, in Molla (2008) study, TOE framework was used for studying the determinants of green IT adoption. Furthermore, Kuo & Dick (2009) also adopted the TOE framework in their study of greening of organization IT. They developed the model which consists of technological, organizational and motivational pressures. Motivational pressures are